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SEVERE SOURCES OF INDUSTRIAL MACHINERY NOISE

Task Report J6331

by

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16 ABSTRACT

This is a task report of effort directed toward the identification of the most severe sources of industrial machinery noise from an occupational perspective, and to develop information on trade associations which would be concerned with noise research.

17 KEY WORDS AND DOCUMENT ANALYSIS

a DESCRIPTORS	b IDENTIFIERS/OPEN ENDED TERMS	c COSATI Field/Group

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ABSTRACT

This is a task report of efforts directed toward the identification of the most severe sources of industrial machinery noise from an occupational perspective, and to develop information on trade associations which would be concerned with noise research.

Accomplishments include: ranked 19 industries in terms of their relative noise intensity and their ability to finance machinery noise reduction; identified 357 machines over 20 industries; identified characteristic sound pressure levels for 236 machines over 19 industries; contacted 58 trade associations; reviewed 320 abstracts of machinery noise publications.

The findings of the study include: the most noise intensive industries are those heavily involved in metal cutting and metal forming; prime machinery noise sources are those machines which cut or form metal, high speed machines and those machines which move material; trade associations provide a limited technology base for reducing machine noise; and open literature should provide a limited base for assessing the technology that has been applied to reducing machine noise.

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SECTION I

CONCLUSIONS

The findings of this study are summarized in four sections.

IDENTIFICATION OF NOISE INTENSIVE INDUSTRIES

The highest category of noise intensive industries includes those briefly involved in metal cutting and metal forming:

Machinery, except electric, SIC35, (1)*
Fabricated metal products, SIC34, (2)
Electrical machinery, SIC36, (4)
Transportation equipment, SIC37, (5)
Primary metals, SIC33, (8)

The middle category of noise intensive industries includes those associated with the use of high speed machines:

Textile mill products, SIC22, (3)
Furniture and fixtures, SIC25, (6)
Lumber and wood products, SIC24, (10)
Printing and publishing, SIC27, (11)
Apparel and related products, SIC23, (18)

The lowest category of noise intensive industries includes those associated with processes:

Food and kindred products, SIC20, (7)
Utilities, SIC49, (9)

*Indicates industrial ranking, see Table 10.

Stone, clay and glass products, SIC32, (13)
Chemical and allied products, SIC28, (15)
Rubber and plastic products, SIC30, (14)
Tobacco manufacturers, SIC21, (15)
Petroleum and coal products, SIC29, (16)
Paper and allied products, SIC26, (17)
Leather and leather products, SIC31, (19)

In general, the higher the ranking the larger is the noise problem in terms of numbers of workers exposed and machinery noise levels and the greater is the financial impact of implementing machinery noise reduction techniques.

MACHINERY NOISE BY INDUSTRY

A search for machinery noise data indicated that most of the available data is in the form of A-weighted sound pressure levels (SPL). Mean SPL was calculated for the machine types within each industry to serve as a gross indicator of the noise level of the machines in the industry. Mean SPL for the machine types ranges from 85 dBA for the leather and leather goods industry machines to 109 dBA for the construction industry machines. Most of the high mean SPL values (above 95 dBA) are associated with industries in which metal cutting and forming are the predominant operations.

NOISE ABATEMENT RESEARCH BY TRADE ASSOCIATIONS

Of the 58 trade associations contacted 22 indicated that they have, are, or are planning noise related research. Sixteen of the associations have conducted noise surveys of machinery, operations or equipment. Six of the associations are conducting programs in these areas:

Burner noise reduction by AGA
Quiet room application by ANPA

Forging noise reduction by FIA
Appliance quieting by AHAM
Vehicle noise reduction by MVMA
Machinery noise reduction by MMPA

Trade associations are not considered a source for large amounts of quantitized data on noise sources, noise levels, and noise treatment technology. Most of the associations are aware of the noise problems within their industries and are keeping abreast of existing and new noise regulations.

MACHINERY NOISE LITERATURE SEARCH

Covering the period 1971 to 1974, 320 publications were identified as pertinent to machinery noise: 224 are United States publications and 96 are from 18 foreign countries. No publications were identified in these industries:

Tobacco manufacturing
Apparel manufacturing
Furniture and fixtures
Printing and publishing
Leather and leather goods
Electrical machinery

The industry with the most publications is chemical and allied products with 42 publications. Petroleum and coal products had 26, utilities had 18, and construction had 17. Of the 11 publications in primary metals only two are from the United States. Several industries appear to be treating the same generic noise problem. Valve noise, pump noise, piping system noise and combustion noise have been treated by several of the process industries.

Open literature should provide a limited base for assessing the technology that has been applied to reducing machine noise.

SECTION II

INTRODUCTION

The objectives of this effort were: to identify the most severe sources of industrial machinery noise from an occupational perspective, and to develop information on trade associations which would be concerned with noise research. These tasks were completed within the limits of the current program funds and are summarized in this document.

Accomplishments of this study include:

- Ranked 19 industries in terms of their relative noise intensity and their ability to finance machinery noise reduction.
- Identified 357 machine types over 20 industries.
- Identified characteristic sound pressure levels for 236 machine types over 19 industries.
- Contacted 58 trade associations to ascertain areas of machinery noise research.
- Reviewed 320 abstracts of machinery noise publications and distributed the publications over 20 industries and a "mixed category."

SECTION III

IDENTIFICATION OF NOISE INTENSIVE INDUSTRIES

The identification of noise intensive industries requires the consideration of: the magnitude of the noise impact on the workers; an estimate of the cost of reducing the machinery noise to a specified level; and some indication of how well an industry is able to bear the cost of the noise reduction. It is recognised that rigorous definitions, quantitisations and ratings are virtually impossible to achieve for several reasons - primarily the lack of a sufficient data base. However, it is also recognised that some structure of the noise/industry/technology/cost relationship must be made to enable the identification of the problem, its scope, rational and effective means of reducing the noise exposure within the technical and financial means of the industry and areas in which governmental assistance can best be applied.

In this section the indicators, or measures of effectiveness, used in the identification of noise intensive industries, the quantisation of these indicators, and a means of ranking the industries are given.

INDICATORS RELATIVE TO NOISE INTENSIVE INDUSTRIES

Indicators chosen as representative of noise intensive industries are:

- Number of production workers exposed relative to 85 dBA criteria. This indicator provides a measure of the magnitude of the noise problem.
- Cost of compliance to the 85 dBA criteria. This indicator measures the cost which must be borne by the industry to reduce the machinery noise to the 85 dBA criteria.

- Cost of compliance as a percent of annual sales. This indicator provides a gross measure of the capacity of the industry to pay for reducing machinery noise.
- Cost of compliance as a percent of capital expenditure. This indicator relates the cost of reducing machinery noise to the amount of money the industry characteristically spends for capital equipment and facilities.
- Mean machinery noise level. This indicator provides a second, although more indirect, measure of the cost of reducing the machine noise to the criteria level.

In summary, five measures of effectiveness are considered; one measures the magnitude of the noise impact, two measure the cost of reducing the machinery noise levels, and two measure the ability of the industry to implement noise reduction measures.

QUANTITISATION OF THE INDICATORS

The indicators have been quantitised by industry and are compiled in Tables 1 through 9. Table 1 is an estimate of production workers over-exposed relative to an 85 dBA criteria. Data for this table were extracted from Reference 1 and restructured by ranking the 19 industries by the number of workers exposed. Two inferences can be drawn from a review of this table: the range of production workers exposed is very large ranging from a high of almost one million workers in the higher ranked industries to a low in the order of three thousand for the lowest ranked industry; and there is no sharp demarcation in the number of workers exposed as a function of rank. The implication of the first inference is very significant. Benefits can be derived in reducing the total number of workers exposed by implementing machinery noise reduction techniques with the highest numbers of exposures. The second inference indicates that there is no sharp difference between what can be termed as noise intensive industries and "quiet" industries.

Table 1. ESTIMATE OF PRODUCTION WORKERS OVEREXPOSED RELATIVE TO 85 dBA CRITERIA

Industry	SIC Code	Thousands of Workers Overexposed to 85 dBA
Electrical Machinery	36	959
Machinery - Except Electric	35	956
Transportation Equipment	37	880
Textile Mill Products	22	855
Food & Kindred Products	20	810
Fabricated Metal Products	34	786
Primary Metals	33	738
Lumber & Wood Products	24	542
Utilities	49	445
Stone, Clay & Glass Products	32	416
Furniture & Fixtures	25	415
Paper & Allied Products	26	395
Rubber & Plastic Products	30	296
Chemical & Allied Products	28	137
Printing & Publishing	27	132
Petroleum & Coal Products	29	58
Tobacco Manufacturers	21	48
Apparel & Related Products	23	12
Leather & Leather Products	31	3
		9,057

Table 2 is a compilation of the cost of reducing the machinery noise to the 85 dBA criteria as a function of the industry. Data for this table were extracted from Reference 1 and the industries ranked by the cost of compliance. A review of this table indicates that significant investments are necessary if all of the industries are to reduce machinery noise levels to the 85 dBA criteria. More than $31 billion needs to be invested for all of the industries with the top industry (utilities) needing an investment in excess of $6 billion.

Table 3 is an estimate of annual sales by industry. Again, the range from top to bottom is large and the gradation is relatively smooth. Data for this table were extracted from Reference 1.

Tables 4 and 5 represent the distribution of capital expenditures for 20 industries over the years 1965 through 1973. The average expenditure during this period is also listed as is the standard deviation. Table 4 is a compilation of the total capital expenditure and Table 5 is a compilation of the capital expenditure for new machines and equipment. Two capital expenditure breakdowns were compiled because it was expected that the total capital expenditure is related to the amount of money the industry is willing to spend while the capital expenditure on new machinery and equipment is related to the amount of money the industry needs to spend. An inspection of the two tables, however, indicates that there is a strong correlation between the two capital expenditure data. The standard deviation data were added to provide an indication of the variation of the expenditure about the mean value. In general, the mean value is somewhere between two and six times as great as the standard deviation. This indicates that there is significant fluctuation of the amount of capital expenditure. Most of the industries have an increasing trend (inflationary) with time, while some industries such as machinery (except the electrical industry) have a cyclic effect superimposed on the inflationary trend which reflects the boom/recession effect as well. Data for these tables are extracted from References 6 and 7. Table 6 is a summary of the average annual capital expenditure by industry.

Table 3: ESTIMATE OF TOTAL COMPLIANCE COST TO 85 dBA CRITERIA

Industry	SIC Code[1]	Total Compliance Cost Millions of Dollars
Utilities	49	6,300
Machinery - Except Electric	35	4,300
Fabricated Metal Products	34	3,200
Transportation Equipment	37	2,900
Textile Mill Products	22	2,700
Food & Kindred Products	20	2,600
Electrical Machinery	36	2,300
Primary Metals	33	1,900
Chemical & Allied Products	28	1,400
Printing & Publishing	27	1,000
Lumber & Wood Products	24	650
Furniture & Fixtures	25	580
Stone, Clay & Glass Products	32	320
Paper & Allied Products	26	500
Rubber & Plastic Products	30	500
Petroleum & Coal Products	29	260
Tobacco Manufacturers	21	90
Apparel & Related Products	23	10
Leather & Leather Products	31	8
		31,618

Table 3. ESTIMATE OF ANNUAL SALES BY INDUSTRY

Industry	SIC Code	1971 Sales Millions of Dollars
Food & Kindred Products	20	103,631
Transportation Equipment	37	86,920
Machinery, Except Electrical	35	55,560
Primary Metals	33	53,067
Chemical & Allied Products	28	51,873
Electrical Machinery	36	49,168
Fabricated Metal Products	34	42,026
Utilities	49	35,662
Petroleum & Coal Products	29	26,935
Printing & Publishing	27	26,887
Paper & Allied Products	26	25,458
Apparel & Related Products	23	25,025
Textile Mill Products	22	24,030
Stone, Clay & Glass Products	32	18,535
Rubber & Plastic Products	30	17,044
Lumber & Wood Products	24	14,931
Furniture & Fixtures	25	9,754
Tobacco Manufacturers	21	5,528
Leather & Leather Products	31	5,219

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SIC Code	[illegible]											
20	[illegible]	1,427	N.A.	N.A.	N.A.	N.A.	[illegible]	N.A.	N.A.	N.A.	N.A.	[illegible]	N.A.
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SIC Code	Industry	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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Table 6. SUMMARY OF AVERAGE ANNUAL CAPITAL EXPENDITURE BY INDUSTRY

SIC Code	Industry	Total Average Capital Expenditures	Average Capital Expenditure on Machinery and Equipment
		Millions of Dollars	
16	Construction	1,263	826
20	Food and Kindred Products	1,734	1,249
21	Tobacco Manufacturers	60	45
22	Textile Mill Products	710	548
23	Apparel and Related Products	227	163
24	Lumber and Wood Products	497	391
25	Furniture and Fixtures	172	107
26	Paper and Allied Products	1,328	1,013
27	Printing, Publishing and Allied Products	710	536
28	Chemical and Allied Products	2,603	2,006
29	Petroleum and Coal Products	862	380
30	Rubber and Misc. Plastic Products	634	505
31	Leather and Leather Goods	57	42
32	Stone, Clay and Glass Products	806	625
33	Primary Metal Industries	2,842	1,926
34	Fabricated Metal Products	965	735
35	Machinery Except Electric	1,513	1,136
36	Electrical and Electronic Machinery	1,274	951
37	Transportation Equipment	1,577	1,167
49	Utilities	12,230	N.A.

Averaged over years 1963 through 1971 except construction and utilities.

Construction expenditures averaged for years 1972 and 1967 only.
Utility expenditures averaged for years 1968 through 1972 and 1963.

Tables 7, 8 and 9 reflect indices of the abilities of the industries to finance the cost of machinery noise reduction. Table 7 ranks the industries by cost of compliance as a percent of annual sales. An inspection of this table indicates that the range is from 18 to 1 percent. Unlike previous indicators the falloff percentage is significant over the top six industries whereby the percentage falls from 18 to 5 percent. Thus for 13 of the 19 industries the cost of compliance is less than 5 percent of the annual sales of the industry. This level is the same order of magnitude as the annual new profit for a viable industry.

Tables 8 and 9 rank the industries by percent of cost of compliance per average capital expenditure. Table 8 reflects the total capital expenditure and Table 9 reflects the capital expenditure on new machinery and equipment. An examination of Table 9 indicates that eight of the 19 industries require from two to five times the average annual capital expenditure on new machinery noise level to the 85 dBA criteria. Conversely, nine of the 19 industries require less than the average annual capital expenditure to reduce the noise level.

RANKING OF THE INDUSTRIES

Ideally, the industries, measures of effectiveness, and weighting factors should be structured into the form of a decision matrix and the industry ranking obtained accordingly. However, the accuracy of the data is such that most of the industry/measure of effectiveness elements are either approximations or average values. Also the establishment of weighting factors requires the assessment of the worth of each element to each measure of effectiveness - this is beyond the scope of this study. Accordingly a rating system is used which ranks each industry within each indicator and then establishes an average rank for each industry. This method applies equal weight to each rank and tends to attenuate the inaccuracies of the data.

Table 7. ESTIMATE OF COST OF COMPLIANCE AS A PERCENT OF ANNUAL SALES*

Industry	SIC Code	Percent Cost of Compliance Per Annual Sales
Utilities	49	18
Textile Mill Products	22	11
Machinery, Except Electrical	35	8
Fabricated Metal Products	34	8
Furniture & Fixtures	25	6
Electrical Machinery	36	5
Primary Metals	33	4
Lumber & Wood Products	24	4
Printing & Publishing	27	4
Transportation Equipment	10	3
Food & Kindred Products	20	3
Chemical & Allied Products	28	3
Stone, Clay & Glass	32	3
Rubber & Plastics Products	30	3
Paper & Allied Products	26	2
Tobacco Manufacturers	21	2
Petroleum & Coal Products	29	1
Leather & Leather Products	31	<1
Apparel & Relat d Products	23	<1

* 1971 Sales.

Table 8. ESTIMATE OF COST OF COMPLIANCE AS A FUNCTION OF AVERAGE ANNUAL TOTAL CAPITAL EXPENDITURE

Industry	SIC Code	Percent Cost Of Compliance Per Average Annual Total Capital Expenditure
Textile Mill Products	22	380
Furniture & Fixtures	25	337
Fabricated Metal Products	34	333
Machinery Except Electric	35	277
Transportation Equipment	37	184
Electrical Equipment	36	180
Food & Kindred Products	20	150
Tobacco Manufacturers	21	150
Printing & Publishing	27	141
Lumber & Wood Products	24	131
Rubber & Plastic Products	30	79
Primary Metals	33	77
Stone, Clay & Glass Products	32	64
Chemical & Allied Products	28	54
Utilities	49	51
Paper & Allied Products	26	41
Petroleum & Coal Products	29	30
Leather & Leather Products	31	14
Apparel & Related Products	23	4

Table 9. ESTIMATE OF COST OF COMPLIANCE AS A FUNCTION OF AVERAGE ANNUAL CAPITAL EXPENDITURE ON NEW MACHINERY & EQUIPMENT

Industry	SIC Code	Percent Cost of Compliance Per Average Annual Capital Expenditure
Furniture & Fixtures	25	542
Textile Mill Products	22	495
Fabricated Metal Products	34	435
Machinery Except Electric	35	370
Transportation Equipment	37	258
Electrical Equipment	36	242
Food & Kindred Products	20	208
Tobacco Manufacturers	21	200
Printing & Publishing	27	190
Lumber & Wood Products	24	186
Primary Metals	33	99
Rubber & Plastic Products	30	99
Stone, Clay & Glass Products	32	83
Chemical & Allied Products	28	70
Petroleum & Coal Products	29	68
Paper & Allied Products	26	49
Utilities	49	N.A.
Leather & Leather Products	31	27
Apparel & Related Products	23	6

Table 10 is a summary of industry ranking. Each industry is given an overall rank based on the average rank achieved in each of the indicators (also tabulated). Industries ranked high have the greatest noise problem in terms of workers exposed and noisy machines and the greatest financial impact of compliance to the 85 dBA criteria. Industries ranked low should be able to implement the noise reduction with a minimum financial impact (assuming the cost of compliance can be achieved). An inspection of the table indicates:

- Most of the industries ranked high are consistently ranked high and most of the industries ranked low are consistently ranked low throughout the indicators.
- Most of the excursions from the average ranking are four or less. The largest excursions occur in:

  Petroleum and coal products. This excursion is generated by the mean machine noise level which, in turn, is driven by the predominance of machine noise level data in the coal mining operations.

  Utilities. The excursion in this industry results from the high cost of compliance and the relatively low annual sales.

  Textile mill products. The excursion is from the relatively low noise levels of those machines which are identified with this industry.

- The rank by workers exposed is in general agreement with the rank by mean machine noise level. Thus two indicators directed toward measuring the same effect by quite diverse data bases are in closer agreement than would have appeared obvious.
- In general, the higher category of noise intensive industries are those heavily involved in metal cutting and metal forming such as:

  Machinery, except electric (1)
  Fabricated metal products (2)
  Electrical machinery (4)
  Transportation equipment (3)
  Primary metals (8)

  } Average rank = 4.0

Table 10. [illegible]

Industry	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Machinery except Electric	1	9	3	3	4	4	1
Fabricated Metal Products	3	6	3	4	3	3	4
Textile Mill Products	3	4	8	2	1	2	11
Electrical Machinery	4	1	7	6	6	6	3
Transportation Equipment	5	3	6	10	5	5	5
Furniture and Fixtures	6	11	12	5	2	1	7
Food and Kindred Products	7	5	4	11	7	7	10
Primary Metal Products	8	7	9	7	12	11	6
Utilities	9	9	1	1	15	17	9
Lumber and Wood Products	10	8	11	8	10	10	8
Printing and Publishing	11	15	10	9	9	9	15
Stone, Clay and Glass Products	12	12	15	13	13	13	13
Chemical and Allied Products	13	14	2	12	14	14	14
Rubber and Plastic Products	14	13	13	14	11	12	17
Tobacco Manufacturers	15	17	17	16	8	8	12
Paper and Allied Products	17	12	14	15	16	16	14
Petroleum and Coal Products	16	16	16	17	17	15	2
Apparel and Related Products	18	18	18	18	18	18	16
Leather and Leather Products	19	19	19	19	19	19	19

- The middle category of noise intensive industries are those with many high speed machines:

  Textile mill products (3)
  Furniture and fixtures (6)
  Lumber and wood products (10)
  Printing and publishing (11)
  Apparel and related products (18)

  } Average rank = 9.6

- The lowest category of noise intensive industries are those which are primarily projects associated:

  Food and kindred products (7)
  Utilities (9)
  Stone, clay & glass products (12)
  Chemical and allied products (13)
  Rubber and plastic products (14)
  Tobacco manufacturers (15)
  Petroleum and coal products (16)
  Paper and allied products (17)
  Leather and leather products (19)

  } Average rank = 13.6

SECTION IV

MACHINERY NOISE BY INDUSTRY

Machine types and noise levels were compiled by industry in order to identify: machine types within each industry, and the noise levels associated with each machine type. Accordingly 357 machine types were identified and distributed over 20 industries. Bases for the identification were:

- Department of Commerce reports of the 1972 Census of Manufacturers, Reference 5. These documents formed the primary basis of the machinery and industry distributions.
- References on machine noise (References 1, 3, 4, 8, 9, 10, 11, 12, 13) yielded both noise level data and information on machines used by industry. Machine types of the construction and utility industries were primarily gathered from these reports.
- Machine types of the electrical and electronic machinery and the transportation equipment industries were augmented from personal background experience.

No attempt was made to be all-inclusive in identifying machinery because much more data were readily available in some industries, such as the fabricated metal products industry, than in others, such as the tobacco manufacturers industry. Also, there are many species of some generic machine types which are in various stages of useful life. Therefore, a rigorous structure of the machine-noise level/industry matrix is very large and beyond the scope of this effort. The machinery noise level, then, is presented as an indicator rather than as an absolute value.

A search for machinery noise data indicated that most of the available data are in the form of A-weighted sound pressure levels. Little noise spectra data were found, with the exception of that in Reference 4.

Table II is a summary of the machinery noise by industry. The complete machine-industry-noise level matrix is given in the appendix to this report. Table II is a compilation of the SIC code for each industry, the industry, the number of machine types identified with each industry, the number of machines for which SPL is available, and the mean SPL for the machine types identified. The mean SPL is intended to serve as a gross indicator of the noise level of the machines in the industry and should not be taken as an indicator of the noise level of the industry (which must be related to the number of machines of each type within the industry).

Noise levels were identified with approximately 67 percent of the machines. This is a relatively high value primarily because many of the machines within the industries could not be readily identified during this effort and many of those machines which were identified were drawn from the noise measurement data base.

Mean SPL for the machine types range from 85 dBA for the leather and leather goods industry machines to 109 dBA for the construction industry machines. Most of the high mean SPL values (above 95 dBA) are associated with industries in which metal forming and cutting are the predominant operations. Noise levels of the petroleum and coal products industry machines are primarily driven by the noise of the machines associated with mining operations.

Table II. SUMMARY OF MACHINE NOISE BY INDUSTRY

SIC Code	Industry	Number of Machine Types Identified	Number of Machines Types With SPL Data	Mean SPL for Machine Types, dBA
16	Construction	36	19	85 (109**)
20	Food and Kindred Products	42	18	94
21	Tobacco Manufacturers	6	0	N.A.
22	Textile Mill Products	15	10	93
23	Apparel and Related Products		Included in SIC 22	
24	Lumber and Wood Products	15	11	96
25	Furniture and Fixtures		Included in SIC 24	
26	Paper and Allied Products	22	9	91
27	Printing, Publishing & Allied Products	22	11	90
28	Chemical and Allied Products	15	15	88
29	Petroleum and Coal Products	29	7	77
30	Rubber and Misc. Plastic Products		Included in SIC 28	
31	Leather and Leather Goods	18	10	85
32	Stone, Clay and Glass Products	12	12	91
33	Primary Metal Industries	38	38	98
34	Fabricated Metal Products	41	27	99
35	Machinery Except Electric	21	17	101
36	Electrical & Electronic Machinery	13	12	99
37	Transportation Equipment	13	12	99
49	Utilities	8	8	95
		357	236	

*SPL adjusted from 90 feet to 3 feet.

SECTION V

NOISE ABATEMENT RESEARCH BY TRADE ASSOCIATIONS

Trade associations were contracted to indicate the level of active interest by trade associations in noise abatement research, indicate the type of noise abatement research being conducted by trade associations, and to ascertain the availability of the results of the research.

Accordingly, a list of 58 trade associations was compiled from Reference 2, and distributed over 20 industries. "Small" associations, with annual budgets of less than $250,000 were not included. Telephone contacts were made to identify the availability of published results of noise research. These results are compiled in Table 12. Some of the comments are summarized here:

- Twenty-two of the associations have, are or are planning noise related "research".
- Sixteen of the associations with noise related "research" have conducted noise surveys of machinery, operations or equipment.
- Six of the associations with noise related research indicated activities in noise reduction. Research includes:

  Burner noise reduction by AGA
  Quiet room application by AHPA
  Appliance quieting by AHAM
  Forging noise reduction by FIA
  Vehicle noise reduction by MVMA
  Machinery noise reduction by WWPA.

- Four associations indicated that noise research results are considered proprietary and expressed concern about releasing the information to a Government agency.
- One association (AAR) indicated that EPA, NAC already has its information.

- The American Trucking Association data are primarily a survey of truck noise levels. Similar, but more extensive information is available from the Motor Vehicle Manufacturers Association.

- Most associations did not express a strong willingness to work with the Government on surveying and assessing the noise problem within the industry. Indeed, three associations were strongly negative about cooperating. The American Textile Manufacturers Institute (ATMI) and the Motor Vehicle Manufacturers Association expressed a willingness to cooperate. The ATMI was particularly interested in establishing a truly representative structure of the textile manufacturer's noise problems, the potential application of technology and the cost of compliance to particular noise levels.

Trade associations are not considered a source for large amounts of quantitized data on noise sources, noise levels and noise treatment technology. Most of the associations are aware of the noise problem and are keeping abreast of existing and new noise regulations. Their member companies are in contact with regional and local DOL/OSHA representatives and inspectors and see this industry/Government point of interface as their primary concern. Three associations have expressed concern over the manner in which environmental regulations have been promulgated without any apparent concern over the economic impact on the industry or the establishment of effective noise abatement technology.

Table 12. SUMMARY OF INDUSTRY/ASSOCIATION/NOISE RESEARCH ACTIVITY SURVEY

SIC Code	Industry/Associations	Research Activity	Publications Available
15	CONSTRUCTION		
	Assoc. Equipment Distributors 615 West 22nd Street Oak Brook, Ill. 60521 (312)654-8650	None	None
	Assoc. General Contractors Amer. 1957 East Street, N.W. Washington, D.C. 20006 (202)393-2040	Research Conducted Through State Chapters	None
16	Construction Specifications Inst. 1717 Massachusetts Avenue, N.W. Washington, D.C. 20036 (202)833-2160	None	None
	Construction Indus. Mfrs. Assoc. Suite 1700, Marine Plaza, 111 East Wisconsin Avenue Milwaukee, Wis. 53202 (414)272-0943	Conducted a Joint Program with Farm and Industrial Equipment Institute	TR-SAE-84 A study of of Noise Induced Hearing Damage for Operators of Farm and Construction Equipment, 1969.
20	FOOD AND KINDRED PRODUCTS		
	Can Manufacturers Inst. 1625 Massachusetts, N.W. Washington, D.C. 20036 (202)232-4677	Plan to start project on in-plant noise reduction in the near future	None

Table 12 (continued). SUMMARY OF INDUSTRY/ASSOCIATIONS/NOISE RESEARCH ACTIVITY SURVEY

SIC Code	Industry/Associations	Research Activity	Publications Available
	National Canners Assoc. 1133 20th Street, N.W. Washington, D.C. 20036 (202)331-5900	None	None
	Packaging Machinery Mfrs. Assoc. 2200 K Street, N.W. Washington, D.C. 20006 (202)331-8181	None	None
21	TOBACCO MANUFACTURERS		
	Tobacco Inst. Inc. 1776 K Street, N.W. Washington, D.C. 20006 (202)296-8634	None	None
22	TEXTILE MILL PRODUCTS		
	American Textile Mfrs. Inst., Inc. 1501 Johnston Bldg. Charlotte, N.C. 28202 (704)334-4734	Survey of Equipment Noise Levels	No Data will be used for OSHA hearings
	Carpet and Rug Inst. 710 Holiday Drive, Box 2048 Dalton, Ga. 30720 (404)278-3176	Survey of Equipment Noise	Report Available

Table 12 (Continued). [illegible]

SIC Code	Industry/Associations	Research Activity	Publications Available
23	APPAREL AND RELATED PRODUCTS		
	Amer. Apparel Mfrs. Assoc. 2611 North East Street Arlington, Va. 22209 (703)524-1864	None	None
	Amer. Footwear Indus. Assoc. 1611 North East Street Arlington, Va. 22209 (703)522-4870	None	None
24	LUMBER AND WOOD PRODUCTS		
	Amer. Forest Inst. 1619 Massachusetts Avenue Washington, D.C. 20036 (202)667-3807	None	None
	Amer. Plywood Assoc. 1119 A Street Tacoma, Wash. 98401 (206)272-2283	None	None
	National Forest Products Assoc. 1619 Massachusetts Avenue, N.W. Washington, D.C. 20036 (202)332-1250	None	None

Table 32 (Continued). SUMMARY OF INDUSTRY/ASSOCIATIONS/MILLS RESEARCH ACTIVITY SURVEY

SIC Code	Industry/Associations	Research Activity	Publications Available
	Western Wood Products Assoc. 1500 Yeon Building Portland, Oregon 9704 (503)224-3930	Program on Machinery Noise	No Reports not yet published (1976)
	National Hardwood Products Assoc. 332 South Michigan Avenue Chicago, Ill. 60604 (312)427-3811	None	None
25	FURNITURE AND FIXTURES		
	National Housewares Mfrs. Assoc. 1130 Merchandise Mart Chicago, Ill. 60654 (312)644-3333	None	None
26	PAPER AND ALLIED PRODUCTS		
	American Paper Inst. 260 Madison Avenue New York, N.Y. 10016 (212)683-8000	None	None
	Fiber Box Assoc. 224 North Michigan Avenue Chicago, Ill. 60604 (312)863-8250	Conducted Survey of Machine by Noise	None

Table 12 (Continued). SUMMARY OF INDUSTRY/ASSOCIATIONS/NOISE RESEARCH ACTIVITY SURVEY

SIC Code	Industry/Associations	Research Activity	Publications Available
27	PRINTING, PUBLISHING AND ALLIED PRODUCTS		
	Amer. Newspapers Publishers Assoc. Post Office Box 598 Easton, Pa. 18042 (215)253-6155	Survey of Machine by Noise and Potential Treatment	No Information is considered proprietary
	Printing Indus. Amer. Inc. 1730 North Lynn Street Arlington, Va. 22209 (703)527-6000	None	None
28	CHEMICAL AND ALLIED PRODUCTS		
	Chemical Specialities Mfrs. Assoc. Inc. 1001 Connecticut Avenue, N.W. Washington, D.C. 20036 (202)872-8108	None	None
	Oil, Chemical and Atomic Workers Union Int'l. 1636 Champa Street Denver, Colo. 80202 (303)266-0811	Survey of machinery Noise and Hearing Damage	EPA/ONU has data

Table 12 (Continued).- [illegible]

SIC Code	Industry/Associations	Research Activity	Publications Available
29	PETROLEUM AND COAL PRODUCTS		
	Amer. Gas Assoc. 1515 Wilson Boulevard Arlington, Va. 22209 (703)524-2000	Program to Reduce Sewer Noise	No Program just started
	Amer. Petroleum Inst. 1801 K Street, N.W. Washington, D.C. 20006 (202)833-5000	None	None
	Bituminous Coal Research, Inc. 350 Hochberg Road Monroeville, Pa. 15146 (412)327-1600	None	None
30	RUBBER AND MISCELLANEOUS PLASTIC PRODUCTS		
	Rubber Mfrs. Assoc. 1901 Pennsylvania Avenue Washington, D.C. 20075 (202)785-1000	None	None
31	LEATHER AND LEATHER GOODS		
	No associations identified.		

Table 12 (Continued). SUMMARY OF INDUSTRY/ASSOCIATIONS/NOISE RESEARCH ACTIVITY SURVEY

SIC Code	Industry/Associations	Research Activity	Publications Available
32	STONE, CLAY AND GLASS PRODUCTS		
	National Concrete Masonry Assoc. 1800 North Kent Street Arlington, Va. 22209 (703)534-8815	Machinery Noise Data	If cleared for release by association
	Glass Container Mfrs. Inst. 1800 K Street, N.W. Washington, D.C. 20006 (202)872-1260	None	None
	Portland Cement Assoc. Old Orchard Road Skokie, Ill. 60076 (312)966-6200	Noise Surveys for Member Companies	Reports considered proprietary
33	PRIMARY METAL INDUSTRIES		
	Aluminum Assoc. 750 Third Avenue New York, N.Y. 10017 (212)972-1800	None	None
	Amer. Iron and Steel Inst. 1000 16th Street, N.W. Washington, D.C. 20036 (202)223-9040	Survey of Noise	No Survey just beginning

Table II (Continued). SUMMARY OF INDUSTRY/ASSOCIATIONS/NOISE RESEARCH ACTIVITY SURVEY

SIC Code	Industry/Associations	Research Activity	Publications Available
33	Amer. Foundrymen's Society Golf and Wolf Roads Des Plaines, Ill. 60016 (312)824-0181	Participating on Hearing Damage Survey	None
-	Forging Industry Assoc. 1111 Illuminating Building 55 Public Square Cleveland, Ohio 44113 (216)781-4260	Program on Machinery Noise Reduction	Yes $50 per copy Six volumes ready Six not yet ready No reproduction rights
	Gray and Ductile Iron Founders Soc. Cast Metals Federation Building Rocky River, Ohio 44716 (216)333-9600	Survey of Machinery Noise	No Just beginning
	Steel Founders Society of Amer. Cast Metals Federation Building Rocky River, Ohio 44116 (216)333-9600	None	None
34	FABRICATED METAL PRODUCTS		
	Air Conditioning/Refrigeration Inst. 1815 North Fort Myer Drive Arlington, Va. 22209 (703)524-8800	None	None

Table 12 (Continued). SUMMARY OF INDUSTRY/ASSOCIATIONS/WHERE RESEARCH ACTIVITY EXISTS

SIC Code	Industry/Associations	Research Activity	Publications Available
36	Amer. Automobile Assoc. 1712 G Street, N.W. Washington, D.C. 20006 (202)333-6000	None	None
"	Assoc. Home Appliance Mfrs. 20 North Wacker Drive Chicago, Ill. 60606 (312)236-2921	Equipment Noise Survey	None
	Farm and Industrial Equipment Inst. 410 North Michigan Avenue Chicago, Ill. 60611 (312)321-1470	Survey of Hearing Damage for Operators	Yes see CDA (52216)
	Industrial Research Inst. 100 Park Avenue New York, N.Y. 10017 (212)683-7626	None	None
	International Snowmobile Assoc. 52-05 Leesburg Pike Falls Church, Va. 22041 (703)379-9100	None	None

Table 12 (Continued). [illegible]

SIC Code	Industry/Associations	Research Activity	Publications Available
36	Natl. Assoc. Engine/Boat Mfrs. Inc. 537 Steamboat Road Greenwich, Conn. 06830 (203)661-9000	None	None
	Natl. Assoc. of Mfrs. 1776 F Street, N.W. Washington, D.C. 20006 (202)331-3790	None	None
35	MACHINERY EXCEPT ELECTRICAL		
	Machinery and Allied Products Inst. 1200 18th Street, N.W. Washington, D.C. 20036 (202)331-8430	None	None
	Natl. Machine Tool Builders Assoc. 7901 Westpark Drive McLean, Va. 22101 (703)893-2900	None	None
	Natl. Tool, Die, and Precision Machining Assoc. 9300 Livingston Road Fort Hill, Md. 20022 (301)248-6200	Mailed Survey	Yes

Table 12 (Continued). SUMMARY OF INDUSTRY/ASSOCIATIONS/NOISE RESEARCH ACTIVITY SURVEY

SIC Code	Industry/Associations	Research Activity	Publications Available
35	Nat'l. Screw Machine Products Assoc. 2860 East 120th Street Cleveland, Ohio 44120 (716)751-6969	Unknown	Unknown
36	ELECTRICAL AND ELECTRONIC MACHINERY		
	Electronic Indust. Assoc. 2001 Eye Street, N.W. Washington, D.C. 20006 (202)459-2200	None	None
	Nat'l. Electrical Mfrs. Assoc. 155 East 44th Street New York, N.Y. 10017 (212)682-1500	None	None
37	TRANSPORTATION EQUIPMENT		
	Amer. Trucking Assoc. 1616 P Street, N.W. Washington, D.C. 20036 (202)797-4000	Truck Noise Research	Yes
	Assoc. of Amer. Railroads 1920 L Street, N.W. Washington, D.C. 20036 (202)293-4000	Railroad Noise Survey	EPA/CHAC has report

Table 12 (Concluded). SUMMARY OF INDUSTRY/ASSOCIATIONS/NOISE RESEARCH ACTIVITY SURVEY

SIC Code	Industry/Associations	Research Activity	Publications Available
37	Transportation Assoc. of Amer. 1101 17th Street, N.W. Washington, D.C. 20036 (202)296-2470	None	None
"	Motor Vehicle Mfrs. Assoc. 320 New Center Building Detroit, Mich. 48202 (313)872-4311	Survey of Motor Vehicle Noise	Yes
49	UTILITIES		
	Amer. Public Power Assoc. 2600 Virginia Avenue, N.W. Washington, D.C. 20037 (202)333-4330	None	None
	Edison Electric Inst. 90 Park Avenue New York, N.Y. 10016 (212)986-4700	None	None
	Natl. Assoc. of Electric Co. 1140 Connecticut Avenue, N.W. Washington, D.C. 20036 (202)223-3460	None	None

SECTION VI

MACHINERY NOISE LITERATURE SEARCH SUMMARY

Abstracts from the literature search covering the period 1971-1974, (compiled as a separate report) relating to machinery noise were reviewed and their areas of activity distributed over the 20 industries. Abstracts which indicate apparent application to several industries were distributed into a "mixed category". A summary of the publication distribution is given in Table 13 and the distribution of the publications over the 21 categories is presented in Table 14. Briefly, the following comments are given:

- 321 publications are identified as pertinent to machinery noise research; 161 are primarily industry oriented and 160 are in the mixed category. The majority (223) are U.S. publications; 98 foreign publications from 19 countries are identified.
- United States publications are distributed into 13 of the 20 industrial categories. No publications were identified in:

  Tobacco manufacturing

  Apparel manufacturing

  Furniture and fixtures

  Printing and publishing

  Leather and leather goods

  Electrical machinery

  Transportation equipment

- The industry with the most publications is chemical and allied products with 42 publications. Petroleum and coal products has 26 publications, Utilities has 18 and construction 18. Of the 11 publications in primary metals only two are from the United States.

Table 13. SUMMARY OF PUBLICATION DISTRIBUTION

321	Publications on Machinery Noise.
161	Publications which are primarily industry oriented.
160	Publications in mixed category applicable to several industries.
333	United States publications broadly scattered except weak in primary metals.
38	German publications broadly scattered throughout.
33	English publications broadly scattered throughout.
6	Russian publications in utility and machine noise, noise measurement, combustion noise, health effects and standards.
7	Japanese publications of fans, turbines, gears, grills and analytical techniques.
6	Swedish publications in construction, primary metals and fabricated metal products.
5	French publications in construction, industrial noise sources, noise measurement and circulation pumps.
5	Polish publications on analysis techniques, pumps and gear noise.
3	Netherlands publications on refinery and plant noise.
2	Australian publications on valve and fan noise.
3	Canadian publications on refinery noise and plant noise standards.
2	Indian publications on industrial noise sources.
1	Austrian publication on noise standards.
1	Belgian publication on industrial noise sources
1	Hungarian publication on pump noise.
1	Iranian publication on oil cushions.
1	Norwegian publication on construction equipment.
1	Swiss publication on heat exchanger noise.
1	Tasmanian publication on water turbines.
1	Yugoslavian publication on milling and grinding.

- Foreign publications are primarily from Germany (38) and England (23). Both of these countries' publications are broadly scattered throughout the categories but pockets of concentration appear in primary metals and fabricated metal products industries and in the mixed category.
- The review of the abstracts resulted in virtually no quantitative technical information which could be used in either assessing machine noise levels, noise reduction techniques, or the effectiveness of the application of technology. The reports must be gathered and reviewed before any assessment of this type can be made.
- Generic noise problems seem to be treated by several industries. For instance:

  Valve Noise Reduction activity is evident in the utilities, chemical and allied products and in the mixed category.

  Pump Noise is treated by chemical and allied products and in the mixed category.

  Piping System Noise reduction techniques are used by utilities, chemical and allied products, petroleum and coal products and in the mixed category.

  Combustion Noise has literature in construction, paper and allied products, chemical and allied products and in the mixed category.

It would appear, therefore, that the transfer of noise reduction technology across industries should be effective and research activities could be defined which have relatively broad applicability to several industries.

Table 14. [illegible]

SIC/Industry	Number of Publications	Areas of Publications
16 Construction Equipment	17	• Construction site noise (5-U.S.) • Pneumatic rock drill (2-U.S., 1-Norway) • Pile drivers (1-Germany, 1-Sweden) • General discourse (1-U.S.) • Construction equipment in general (2-U.S.) • Cooling systems (1-France, 1-England) • Compressors (1-U.S.) • Pneumatic equipment (1-England, 1-U.S.)
20 Food and Kindred Products	6	• Agricultural machinery (3-U.S.) • Bottle cap plant noise (1-U.S.) • Brewery noise (1-U.S.) • Agricultural noise (1-U.S.)
21 Tobacco Manufacturers	None	
22 Textile Mill Products	5	• Rotating textile spindles (1-U.S.) • Textile machinery noise (1-U.S.) • Textile manufacturers noise sources (1-U.S.) • Guidelines for noise control (2-U.S.)
23 Apparel	None	
24 Lumber and Wood Products	3	• Saws (chain) (1-U.S.) • Planer (2-U.S.)
25 Furniture and Fixtures	None	

Table 14 (continued). MACHINERY NOISE PUBLICATION DISTRIBUTION

SIC/Industry	Number of Publications	Areas of Publication
26 Paper and Allied Products	6	• Medical aspects of noise (1-U.S.) • Stock-preparation machinery (1-U.S.) • Compressors (1-U.S.) • Gears (3-U.S.)
27 Printing, Publishing	None	
28 Chemical and Allied Products	42	• Valve noise (17-U.S., 2-Germany, 1-Australia) • Piping noise (3-U.S.) • Combustion noise (2-U.S.) • Centrifugal compressor (1-U.S.) • Pumps (2-U.S., 1-England) • Heat exchangers (1-Switzerland) • Exhaust vent (1-U.S.) • Acoustic insulation (1-U.S.) • Process noise (10-U.S.)
29 Petroleum and Coal Products	26	• Process machinery noise (2-U.S.) • Fan noise (2-U.S., 1-Australia) • Furnace and heater noise (2-U.S.) • Steam pipeline noise (1-U.S.) • Stack noise (1-U.S.) • Flare noise (1-U.S.) • Refinery noise (7-U.S., 1-Netherlands, 1-Canada, 1-England) • Rack noise location (1-U.S.) • Noise in coal preparation plants (2-U.S.) • Noise in underground operations (2-U.S., 1-England) • Coal car unloading (1-U.S.)

Table 14 (continued). MACHINERY NOISE PUBLICATION DISTRIBUTION

SIC/Industry	Number of Publications	Areas of Publication
30 Rubber and Plastic Products	6	• Plant noise sources (2-U.S.) • Processing plant noise (1-U.S.) • Materials handling (1-U.S.) • Combustion (1-England) • Health aspects (1-U.S.S.R.)
31 Leather and Leather Goods	None	
32 Stone, Clay and Glass Products	5	• Ball-mill noise (1-U.S.) • Cement plant noise (1-Germany) • Quarrying noise (3-U.S.)
33 Primary Metals	11	• Electric-arc steel plant (1-England) • Steel plant noise (1-Germany) • Forging (3-U.S., 1-Germany, 1-England) • Air conditioning (1-Germany) • Foundry noise sources (2-Sweden, 1-Germany, 1-England, 1-U.S.)
34 Fabricated Metal Products	12	• Impact machines (2-U.S.) • Metal forming (1-Germany) • Riveting machines (2-U.S.) • Cablemaking machines (2-Germany) • Punch presses (3-U.S., 2-Sweden)
35 Machinery Except Electrical	3	• Milling and grinding (1-Yugoslavia) • Spherical tool against vibrating rod (1-U.S.) • Scale models of turbomachinery facility (1-U.S.)

Table 34 (continued). MACHINERY NOISE PUBLICATION DISTRIBUTION

SIC/Industry	Number of Publications	Areas of Publication
36 Electrical Machinery	None	
37 Transportation Equipment	None	
49. Utilities	10	• Fans for utility boilers (1-Japan) • Switching rooms (1-U.S.S.R.) • Power plant noise (4-U.S.) • Valves for steam plants (1-U.S.) • Machinery noise sources (1-U.S.) • Gas turbines (1-U.S.) • New plant noise considerations (1-U.S., 2-Netherlands, 2-Germany) • Steam piping systems (2-U.S., 1-England)
Mixed Category:		
Industrial Noise Sources	27	• Identification and surveys (2-Germany, 2-England, 2-India, 2-U.S.) • Noise criteria (2-U.S.) • Plant noise control approaches (13-U.S., 1-Canada, 1-Germany, 1-Belgium, 1-France)
Noise Measurement Techniques	18	• Machines in reverberation rooms (2-U.S.) • Principles of perception and measurement (1-France) • Plant noise measurement techniques (2-U.S.) • Machine noise measurement techniques (9-U.S., 1-U.S.S.R., 1-Germany, 1-France) • Errors in measurement of machine noise (1-Germany)

Table 14 (continued). MACHINERY NOISE PUBLICATION DISTRIBUTION

SIC/Industry	Number of Publications	Areas of Publication
Mixed Category (continued)		
Noise Criteria and Standards	11	• Community Impact (4-U.S.) • Standards (1-Canada, 1-U.S.S.R., 1-Australia, 1-Sweden, 3-U.S.)
Analysis Techniques	5	• Nomograms (1-Germany) • Empirical (1-Japan) • Dynamic analysis (2-U.S., 1-Poland)
Equipment, Mechanical	25	• Conveyors (1-Germany) • Compressors (9-U.S., 1-Germany) • Gas turbines (1-U.S., 1-Japan, 1-England) • Lift truck (1-U.S.) • Power tools (1-U.S.) • Prime mover (1-U.S.) • Heat collectors (1-England)
Equipment, Pneumatic	24	• Fan noise (5-U.S., 2-Japan, 1-Germany) • Combustion noise (4-U.S., 1-U.S.S.R., 2-Germany, 6-England) • Noise from airflow through a grill (1-Japan) • Exhaust noise (2-U.S.)
Equipment, Hydraulic	15	• Pumps (3-Poland, 2-Hungary, 1-U.S.) • Valves (1-U.S.) • Piping systems (1-U.S.) • Water turbines (1-Yugoslavia) • Oil cushion (1-Iran) • Hydraulic equipment (5-U.S., 1-England

Table 14 (concluded). MACHINERY NOISE PUBLICATION DISTRIBUTION

SIC/Industry	Number of Publications	Areas of Publication
Mixed Category (concluded)		
Components	10	• Gears (4-U.S., 1-Poland, 1-Japan) • Motor (1-England) • Bearings (2-U.S.) • Clutch (1-U.S.)
Vibration Isolation	8	• Correlation of machine vibration and radiated noise (1-England) • Structural damping (1-U.S.) • Machinery foundations (1-U.S.) • Machine noise reduction (4-U.S., 1-U.S.S.R.)
Acoustical Treatment	16	• Barriers and enclosures (5-U.S., 1-Germany) • Ducts and pipes (3-U.S.) • Fluid and electrical components (2-U.S.) • Laminated metal composites (1-U.S.) • Machines (5-U.S.)
Heating, Ventilating and Air Conditioning	11	• Air handling systems (1-U.S.) • Residential air conditioner (2-U.S.) • Air conditioner cabinet (1-Germany) • Chiller (2-U.S.) • Cooling tower (1-Germany) • Circulating pump (1-France) • Unducted HVAC equipment (2-U.S.) • Duct systems (2-U.S.) • Fans (1-Germany)

SECTION VII

REFERENCES

1. Impact on Noise Control at the Workplace, Report Number 2671, Bolt, Beranek and Newman, October 29, 1973.

2. Encyclopedia of Associations, v 1, N. Fisk, editor, Gale Research Co., Book Tower, Detroit, Michigan.

3. Noise From Power Plant Equipment, The Institute of Mechanical Engineers, Proceedings 1966-67, v 181, part 3G, September 21-23, 1966 (British Publication).

4. Karplus, H and Donvallet, G. L., A Noise Survey of Manufacturing Industries, American Industrial Hygiene Association Quarterly, v 14, n 4, December 1953.

5. Preliminary Report, 1972 Census of Manufacturers, Industry Series, U.S. Department of Commerce, Social and Economic Statistics Administration, Bureau of Census, Reports MC 72(P)-35B-2, MC 72(P)-35B-3, MC 72(P)-35C-1, MC 72(P)-35D-2, MC 72(P)-35D-3, MC 72(P)-35D-1, MC 72(P)-35D-2, MC 72(P)-35D-3, MC 72(P)-35D-4, MC 72(P)-35D-5, MC 72(P)-35B-9, MC 72(P)-1.

6. Annual Survey of Manufacturers, 1970-1971, Surveys also for years 1968-1969, 1967 and 1966, U.S. Department of Commerce, Social and Economic Statistics Administration, Bureau of Census.

7. Statistical Abstract of the United States, 1973, 94th Annual Edition, U.S. Department of Commerce, Social and Economic Statistics Administration, Bureau of the Census.

8. Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances, NTID300.1, U.S. Environmental Protection Agency, December 31, 1971.

9. Miller, R. K., You Can Reduce Plant Noise, Food Engineering, March 1973.

10. Cannon, R. H., Noise Reduction for Equipment Operations Underground, Mining Congress Journal, March 1972.

11. Satek, J. E., Underground Noise Control: The New Challenge, Coal Age, December 1971.

12. Lamonica, J. A., et al, Noise in Underground Coal Mines, RI 7550, USDI, Bureau of Mines, August 1971.

13. Willoughby, R. A. and Parker, E., Reducing Pneumatic Tool Noise, Plant Engineering, September 6, 1973.

APPENDIX

INDUSTRY MACHINE NOISE LEVEL DATA

SIC Code 15 - Construction Other than Building Construction

Machine	Overall Level dBA	Ref. Number
Bulldozers	80[1] (104)[2]	8
Scrapers	88[1] (112)	8
Trucks (Construction)	91[1] (113)[2]	8
Pavers Self-propelled	89[1] (113)[2]	8
Backhoes	85[1] (109)[2]	8
Compactors		
Graders	85[1] (109)[2]	8
Frontloaders	79[1] (103)[2]	8
Shiploaders		
Concrete Mixers	85[1] (109)[2]	8
Conveyors		
Vibrators	76[1] (100)[2]	8
Concrete Pumps	82[1] (106)[2]	8
Rock Crushers		
Cranes	83[1] (107)[2]	8
Pile Drivers	101[1] (125)[2]	8
Drop Hammers		
Pneumatic Tools	85[1] (109)[2]	8
Off-Highway Tractors	80[1] (104)[2]	8
Draglines		
Shovels		
Street Sweeper		
Rock Drill	98[1] (122)[2]	8
Derrick	88[1] (112)[2]	8
Clamshell		
Ripper		
Pipe Layer		
Roller		
Trencher		
Forklift		

SIC Code 16 (concluded) - Construction Other than Building Construction

Machine	Overall Level dBA	Ref. Number
Travel Lift		
Compressor	81[1](105)[2]	8
Generator	78[1](102)[2]	8
Jackhammer	88[1](112)[2]	8
Stripping Pump		
Well-Point Pump		

[1]SPL measured at 50 ft from machine.

[2]SPL adjusted to 3 ft by adding 6 dBA for distance halving.

SIC Code 20 - Food and Kindred Products

Machine	Overall Level dBA	Ref. Number
Bottling and Packaging Machinery	93	9
Washing and Sterilising Equipment		
Pasteurisers		
Homogenisers	93[2]	9
Ice Cream Freezer:		
Butter and Cheese Processing Machinery		
Dry Milk Processing Machinery		
Slicers		
Choppers	9[1]	4
Grinders		
Dicers		
Mixers		
Tenderisers		
Ovens		
Continuous Breadmaking Equipment		
Wrapping Machines		
Bottling Equipment		
Meat and Poultry Processing Equipment		
Fruit and Vegetable Canning Machinery		
Flour and Grainmill Machinery		
Sugar Plant Machinery		
Oilseed Crushing and Extracting Machinery		
Bottle Washers and Sterilisers	[2]	9
Uncasers and Casers		
Capping Machines		
Packing and Packaging Machines		
Carbonators		
Filling and Labeling Machines		
Holding Machine	80[1]	4
Peanut Blanching Machine	85[1]	4
Bottle Filler	90[2]	9

SIC Code 20 (concluded) - Food and Kindred Products

Machine	Overall Level dBA	Ref. Number
Lift Truck	91[2]	9
Peanut Sizing Machine	95[2]	9
Salt Pulverizer	95[2]	9
Vibrating Conveyor	91[2]	9
Metal Conveyor for Bottles	94[2]	9
Pecan Shell Cracker	101[2]	9
Paper Container Shear	100[2]	9
Candy Cane Twister	95[2]	9
Wash Tank	100[2]	9
Refrigeration Compressor	100[2]	9
Candy Print Machine	99[2]	9

[1]SPL measured 3 to 5 ft from machine.
[2]SPL measurement distance not specified.

SIC Code 21 - Tobacco Manufacturers

Machine	Overall Level dBA	Ref. Number
Conveyors		
Driers		
Fans		
Cutting Equipment		
Washing Equipment		
Packaging Equipment		

SIC Code 22 - Textile Mill Products
(Includes Apparel and Other Finished Products, SIC 23)

Machine	Overall Level dBA	Ref. Number
Cleaning and Opening Machinery		
Carding and Combing Machines		
Drawing and Roving Frames		
Spinning Frames	82[1]	4
Twisting Frames	83[1]	4
Yarn Preparing Machines	97[1]	4
Power Looms	103[1]	4
Knitting Machines		
Bleaching, Dyeing and Finishing Machinery	100[2]	4
Drying Machinery		
Reducing Machines	96[1]	4
Reducer Transfer Machines	89[1]	4
Combing Machines	95[1]	4
Pin Drafters	92[1]	4
Preparers	90[1]	4

[1] SPL measured 3 to 5 ft from machine.
[2] SPL measurement distance not specified.

SIC Code 24 - Lumber and Wood Products
(Includes Furniture and Fixtures, SIC 25)

Machine	Overall Level dBA	Ref. Number
Veneer and Plywood making Machinery		
Saws	111[1]	4
Jointers	98[1]	4
Matchers		
Molders	99[1]	4
Mortisers		
Shapers	89[1]	4
Tenoners	95[1]	4
Lathes	98[1]	4
Planing Machines	108[1]	4
Surfacing Machines	98[1]	4
Drills		
Barkers	91[1]	4
Slashers	97[1]	4
Sanders	85[1]	4

[1] SPL measured 3 to 5 ft from machine.

SIC Code 26 - Paper and Allied Products

Machine	Overall Level dBA	Ref. Number
Barkers	91[1]	4
Chippers		
Knotters		
Splitters		
Chipscreens		
Grinders		
Deckers		
Digesters		
Beaters		
Jordans		
Calenders	93[1]	4
Fourdriniers		
Bagmaking Machines		
Corrugated Boxmaking Machines	97[1]	4
Box, Carton and Shipping Containermaking Machines	85[1]	4
Toilet Roll and Napkinmaking Machines		
Slashers	97[1]	4
Pulp Preparation Machine	82[1]	4
Mixers	94[1]	4
Paper Machines	88[1]	4
Pumps	92[1]	4

[1]SPL measured 3 to 5 ft from machine.

SIC Code 27 - Printing, Publishing and Allied Products

Machine	Overall Level dBA	Ref. Number
Lithographic Printing Presses		
Newspaper Presses	93[1]	4
Business Form Presses		
Commercial Presses		
Gravure		
Flexographic		
Typesetting Machinery	81[1]	4
Saddle Binding Equipment		
Perfect and Hard Case Binding Equipment		
Electrotyping Machines		
Stereotyping Machines		
Paper Cutting Machines		
Collating Machines	90[1]	4
Gathering Machines		
Printer-Slotters	98[1]	4
Stitchers	85[1]	4
Folders	94[1]	4
Shears	103[1]	4
Ink Mills	91[1]	4
Cleaning Tanks	87[1]	4
Newsprint Rewinders	83[1]	4
Air Ejectors	81[1]	4

[1]SPL measured 3 to 5 ft from machine.

SIC Code 28 - Chemical and Allied Products
(Includes Rubber and Miscellaneous Plastic Products SIC 30)

Machine	Overall Level dBA	Ref. Number
Ink Mills	91[1]	4
Pigment Mills	91[1]	4
Pebble Mills	80[1]	4
Mixers	80[1]	4
Drum Cleaners	78[1]	4
Five-Roll Mills	97[1]	4
Hammer Mills	98[1]	4
Compounding Rolls	93[1]	4
Ball Mills	99[1]	4
Fabric Coaters	81[1]	4
Rewind, Fabric Beaming	80[1]	4
Rotary Kilns	89[1]	4
Rubber Mills	86[1]	4
Tread Tubers	90[1]	4
Curing Presses	94[1]	4

[1]SPL measured 3 to 5 ft from machine.

SIC Code 29 - Petroleum and Coal Products

Machine	Overall Level dBA	Ref. Number
Rotary Drilling Surface Equipment		
Rotary Drilling Subsurface Equipment		
Cable Tool Drilling Machinery		
Flowing Well Equipment		
Rod Lifting Machinery		
Pumping Units		
Oil and Gas Separating, Metering and Treating Equipment		
Well Surveying Machinery		
Crushing, Pulverising and Screening Machinery	86[2]	10
Drills	110[2]	10
Cutting Machines	96[1]	12
Longwall Mining Machines		
Gathering Arm Loading Machines	99[1]	12
Slusher Hoists Loading Machines		
Continuous Mining Machines	97[1]	12
Borers		
Rippers		
Shuttle Cars (Loading)	93[1]	12
Mine Cars		
Floatation Machines		
Wet Cyclones		
Centrifugal Driers		
Scrubbers		
Thermal Driers		
Feeders		
Grinding Mills		
Screens		
Shakers		
Roof Bolter	112[1]	11

[1] SPL measured within 3 ft.

[2] SPL measurement distance not specified.

SIC Code 31 - Leather and Leather Products

Machine	Overall Level dBA	Ref. Number
Fleshing Machines	89[1]	4
Hair Driers	88[1]	4
Lime Mixing Tubs	77[1]	4
Setting Out Machines	103[1]	4
Splitting Machines	85[1]	4
Coloring Drums	90[1]	4
Plating	81[1]	4
Seasoning Machines	80[1]	4
Spraying Machines	78[1]	4
Measuring Machines	77[1]	4

[1]SPL measured 2 to 5 ft from machine.

SIC Code 32 - Stone, Clay and Glass Products

Machine	Overall Level dBA	Ref. Number
Clay Crushers	92[1]	4
Clay Tile Extrusion Machines	82[1]	4
Packing Machines	86[1]	4
Bottle Forming Machines	98[1]	4
Mixers	93[1]	4
Pneumatic Chippers	84[1]	4
Cutoff Saws	89[1]	4
Stone Planers	98[1]	4
Cranes	84[1]	4
Stone Saws	99[1]	4
Concrete Aggregate	89[1]	4
Clay Tile Kiln (Unloading)	97[1]	4

[1]SPL measured 3 to 5 ft from machine.

SIC Code 33 - Primary Metal Industries

Machine	Overall Level dBA	Ref. Number
Grinders	90[1]	4
Pneumatic Chippers	119[1]	4
Furnaces (Ingot Heating)	93[1]	4
Furnaces (Oil Heating)	93[1]	4
Wood Planers	107[1]	4
Friction Saws	107[1]	4
Shakeouts	103[1]	4
Pneumatic Rams	84[1]	4
Tumblers	99[1]	4
Pushup Machines	99[1]	4
Core Blowers	116[1]	4
Core Draw Vibrators	108[1]	4
Air Hoists	108[1]	4
Electric Furnaces	96[1]	4
Sand Slingers	96[1]	4
Jolt Squeeze Machines	97[1]	4
Crucible Heaters	81[1]	4
Roughing Mills	102[1]	4
Levelers	90[1]	4
Decoilers	116[1]	4
Annealing Furnaces	93[1]	4
Lectromelt Furnaces	93[1]	4
Open Hearth Furnaces	80[1]	4
Scarfing Equipment	86[1]	4
Bloomer Mills	90[1]	4
Strip Mills	97[1]	4
Conveyors	96[1]	4
Forging Hammers	110[1]	4
Coke Ovens	93[2]	1
Sinter Plants	100[2]	1
Blast Furnaces	93[2]	1

SIC 33 (concluded) - Primary Metal Industries

Machine	Overall Level dBA	Ref. Number
Basic Oxygen Furnaces	85[2]	1
Soaking Pits	94[2]	1
Rolling Mills	85[2]	1
Continuous Picklers	82[2]	1
Pipe Mills	86[2]	1
Wire Drawing	93[2]	1
Nail Mills	96[2]	1

[1]SPL measured 3 to 5 ft from machine.
[2]SPL measurement distance not identified.

SIC Code 34 - Fabricated Metals Products

Machine	Overall level dBA	Ref. Number
Boring Machines	97[1]	4
Drilling Machines	98[1]	4
Gear-Cutting Machines	88[1]	4
Grinding Machines	106[1]	4
Polishing Machines	95[1]	4
Lathes	107[1]	4
Milling Machines	89[1]	4
Saws	107[1]	4
Broaching Machines		
Planers		
Shapers	93[1]	4
Cutoff Machines	103[1]	4
Tapping Machines	94[1]	4
Threading Machines		
Automatic Chucking Lathes		
Screw Machines	90[1]	4
Station and Transfer Machines		
Electric Discharge Machines		
Electrochemical Machines		
Honing and Lapping Machines		
Welding Machines	82[1]	4
Punches	98[1]	4
Shears	93[1]	4
Bending Machines	92[1]	4
Forming Machines	108[1]	4
Mechanical Presses	107[1]	4
Hydraulic Presses		
Pneumatic Presses	101[1]	4
Extrusion Presses		
Headers and Upsetters	106[1]	4

SIC Code 34 (concluded) - Fabricated Metals Products

Machine	Overall Level dBA	Ref. Number
Gaging Machines		
Gear and Spline Rolling Machines	89[1]	4
Thread Rolling Machines	89[1]	4
Marking Machines		
Riveting Machines	117[1]	4
Diecasting Machines		
Impact Wrenches		
Power Driven Hand Tools	93[2]	4
Drop Hammers	111[1]	4
Sandblast Machines	123[1]	4
Vibrators	104[1]	4

[1] SPL measured 2 to 5 ft from machine.
[2] SPL measurement distance not specified.

SIC Code 35 - Machinery Except Electric

Machine	Overall Level dBA	Ref. Number
Milling Machines	89[1]	4
Boring Machines	97[1]	4
Pneumatic Presses	101[1]	4
Hob Grinders	89[1]	4
Multiple Drills	96[1]	4
Turret Lathes	107[1]	4
Welders	112[1]	4
Riveting Machines	125[1]	4
Chippers	117[1]	4
Grinders	95[1]	4
Shears	94[1]	4
Punch Press	99[2]	4
Drilling Machines	98[1]	4
Gear Cutting Machines	99[1]	4
Lapping, Polishing and Buffing Machines		
Broaching Machines		
Planers		
Shapers	91[1]	4
Tapping Machines	96[1]	4
Saws	107[1]	4
Thread Machines		

[1] SPL measured 2 to 3 ft from machine.

[2] SPL measurement distance not specified.

SIC Code 36 - Electrical and Electronic Machinery

Machine	Overall Level dBA	Ref. Number
Drilling Machines	98[1]	4
Grinding Machines	106[1]	4
Polishing Machines	95[1]	4
Saws	107[1]	4
Tapping Machines	94[1]	4
Threading Machines		
Welding Machines	82[1]	4
Punches	98[1]	4
Shears	93[1]	4
Bending Machines	94[1]	4
Forming Machines	108[1]	4
Riveting Machines	117[1]	4
Power Driven Hand Tools	102[2]	4

[1] SPL measured 2 to 3 ft from machine.

[2] SPL measurement distance not specified.

SIC Code 37 - Transportation Equipment

Machine	Overall Level dBA	Ref. Number
Riveting Machines	111[1]	4
Drills	88[1]	4
Saws	107[1]	4
Routers	86[1]	4
Welding Machines	82[1]	4
Punches	98[1]	4
Shears	93[1]	4
Bending Machines	92[1]	4
Forming Machines	108[1]	4
Mechanical Presses	101[1]	4
Hydraulic Presses		
Pneumatic Presses	101[1]	4
Impact Wrenches		
Power Driven Hand Tools	95[2]	11

[1] SPL measured 3 to 5 ft from machine.

[2] SPL measurement distance not specified.

SIC Code 49 - Utilities

Machine	Overall Level dBA	Ref. Number
Fans	110[2]	3
Gas Turbines	90[2]	3
Oil Burners	85[2]	3
Diesel Engines	100[2]	3
Rotary Blowers	130[2]	3
Turbo-Alternators	85[2]	3
Feed Pumps	90[2]	3
Transformers	60 to 100[1] (Size Dependent)	3

[1]Noise measurement distance not specified.